APPENDIX H

UPTAKE FACTORS

Table H-1. Uptake Factors for Concentrations in Food Items

COPEC	Soil to Plants (Cp)	Reference	Soil to Worms (Cw)	Reference	Soil to Small Mammals (Cm)	Reference
Antimony	EXP(0.938*LN(Cs)-3.233)	EPA, 2005	Cs	EPA, 2005	0.001*50*Cp	EPA, 2005[a]
Cadmium	EXP(0.546*LN(Cs)-0.475)	Bechtel-Jacobs, 1998	EXP(0.795*LN(Cs)+2.114)	Sample et al., 1999	EXP(0.4723*LN(Cs)-1.2571)	Sample et al., 1998b
Chromium	0.041*Cs	Bechtel-Jacobs, 1998	0.306*Cs	Sample et al., 1999	EXP(0.7338*LN(Cs)-1.4599)	Sample et al., 1998b
Copper	EXP(0.394*LN(Cs)+0.668)	Bechtel-Jacobs, 1998	0.515*Cs	Sample et al., 1999	EXP(0.1444*LN(Cs)+2.042)	Sample et al., 1998b
Lead	EXP(0.561*LN(Cs)-1.328)	Bechtel-Jacobs, 1998	EXP(0.807*LN(Cs)-0.218)	Sample et al., 1999	EXP(0.4422*LN(Cs)+0.0761)	Sample et al., 1998b
Mercury	0.652*Cs	Bechtel-Jacobs, 1998	1.693*Cs	Sample et al., 1998a	0.0543*Cs	Sample et al., 1998b
Selenium	EXP(1.104*LN(Cs)-0.677)	Bechtel-Jacobs, 1998	EXP(0.733*LN(Cs)-0.075)	Sample et al., 1999	EXP(0.3764*LN(Cs)-0.4158)	Sample et al., 1998b
Silver	0.014*Cs	Bechtel-Jacobs, 1998	2.045*Cs	Sample et al., 1998a	0.004*Cs	Sample et al., 1998b
Thallium	0[b]	Efroymson et al., 1997	0.263*Cs	USACHPPM, 2004	0.102*Cs	Sample et al., 1998b
Zinc	EXP(0.554*LN(Cs)+1.575)	Bechtel-Jacobs, 1998	EXP(0.328*LN(Cs)+4.449)	Sample et al., 1999	EXP(0.0706*LN(Cs)+4.3632)	Sample et al., 1998b
Total PCBs	0.005*Cs	Travis and Arms, 1988	1.1*Cs	Jager, 1998[c]	3.5*Cs	Travis and Arms, 1988
Total DDT[e]	EXP(0.7524*LN(Cs)-2.5119)	Bechtel-Jacobs, 1998	EXP(0.8561*LN(Cs)+2.1287)	EPA, 2005	EXP(0.663*LN(Cp)+2.3833)	EPA, 2005[a]
2,6-DNT	2.35*Cs	Travis and Arms, 1988	Cs	Assumed[d]	0	ATSDR, 1998
HMX	EXP(1.818+0.7458*LN(Cs))	CH2MHill, 2005	1*Cs	CH2MHill, 2005	0	Assumed negligible
HPAH[f]	EXP(0.975*LN(Cs)-2.0615)	EPA, 2005	1.33*Cs	Jager, 1998	0	EPA, 2005
LPAH[g]	12.2*Cs	EPA, 2005	4.4*Cs	Jager, 1998	0	EPA, 2005

DDT - dichlorodiphenyltrichloroethane
2,6-DNT – 2,6-dinitrotoluene
EXP – exponential
LN – natural log
PCB – polychlorinated biphenyl
C_p – concentration in plant
C_w – concentration in worm
C_m- concentration in mammal

(a) The regression equations cited in USEPA (2005) for uptake of antimony and Total DDT to small mammals is based on a diet comprised of 100% invertebrates (worms). To be consistent with wildlife at this site, small mammal concentrations were based on a herbivorous diet (i.e., 100% plants) as in the case of the vole.
(b) Assumed to be negligible.
(c) To determine earthworm uptake factors for PCBs: regression equations from Jager, 1998 were used as follows:
log Kww = 0.87*log Kow – 2
where Log Kow = 6.99 and Kww = 12058.7; Then Kww converted to Kdw. Assuming 16% solids, results in Kdw = 75366.8.
Kd = foc * Koc. If foc= 0.01 (assumes 1% organic carbon content) and Koc =1096478.2, then Kd = 10965.
BAF = Kww (L/Kg worm dw) / Kd (L/kg soil dw); thus, BAF = 12058.7/10965 = 1.1
(d) Due to the lack of uptake factors to worms, their concentrations were conservatively assumed to be equivalent to soil concentrations (USEPA, 2005).
(e) Total DDT is the sum of 4,4'-DDT, 4,4'-DDE, and 4,4'-DDD.
(f) HPAH - uptake factors based on benzo(a)pyrene.
(g) LPAH - uptake factors based on naphthalene.

Table H-2. Bioaccumulation Factors for COPECs Based on Maximum Soil Concentrations

COPEC	Maximum Cs (mg/kg)	Soil to Plants (Cp)	Reference	Soil to Worms (Cw)	Reference	Soil to Small Mammals (Cm)	Reference
Antimony	0.67	0.027	EPA, 2005	0.67	EPA, 2005	0.001	EPA, 2005 [(a)]
Cadmium	1.40	0.747	Bechtel-Jacobs, 1998	10.8	Sample et al., 1999	0.333	Sample et al., 1998b
Chromium	114.00	4.67	Bechtel-Jacobs, 1998	34.9	Sample et al., 1999	7.50	Sample et al., 1998b
Copper	62.00	9.92	Bechtel-Jacobs, 1998	31.9	Sample et al., 1999	14.0	Sample et al., 1998b
Lead	234.00	5.65	Bechtel-Jacobs, 1998	65.7	Sample et al., 1999	12.0	Sample et al., 1998b
Mercury	0.482	0.314	Bechtel-Jacobs, 1998	0.82	Sample et al., 1998a	0.026	Sample et al., 1998b
Selenium	0.70	0.343	Bechtel-Jacobs, 1998	0.71	Sample et al., 1999	0.577	Sample et al., 1998b
Silver	4.81	0.067	Bechtel-Jacobs, 1998	9.84	Sample et al., 1998a	0.019	Sample et al., 1998b
Thallium	0.185	0[(b)]	Efroymson et al., 1997	0.049	USACHPPM, 2004	0.019	Sample et al., 1998b
Zinc	110.00	65.3	Bechtel-Jacobs, 1998	399.7	Sample et al., 1999	109.4	Sample et al., 1998b
Total PCBs	0.07	0.00035	Travis and Arms, 1988	0.1	Jager, 1998[(c)]	0.245	Travis and Arms, 1988
Total DDT[(e)]	0.36	0.04	Bechtel-Jacobs, 1998	3.50	EPA, 2005	1.23	EPA, 2005[(a)]
2,6-DNT	0.20	0.47	Travis and Arms, 1988	0.20	Assumed[(d)]	0	ATSDR, 1998
HMX	0.69	4.67	CH2MHill, 2005	0.69	CH2MHill, 2005	0	Assumed negligible
HPAH[(f)]	0.1760	0.023	EPA, 2005	0.234	Jager, 1998	0	EPA, 2005
LPAH[(g)]	0.0340	0.415	EPA, 2005	0.150	Jager, 1998	0	EPA, 2005

DDT - dichlorodiphenyltrichloroethane
2,6-DNT – 2,6-dinitrotoluene
EXP – exponential
PCB – polychlorinated biphenyl
C_s – concentration in soil
C_p – concentration in plant
C_w – concentration in worm
C_m- concentration in mammal

(a) The regression equations cited in USEPA (2005) for uptake of antimony and Total DDT to small mammals is based on a diet comprised of 100% invertebrates (worms). To be consistent with wildlife at this site, small mammal concentrations were based on a herbivorous diet (i.e., 100% plants) as in the case of the vole.

(b) Assumed to be negligible.

(c) To determine earthworm uptake factors for PCBs: regression equations from Jager, 1998 were used as follows:
log Kww = 0.87*log Kow – 2
where Log Kow = 6.99 and Kww = 12058.7; Then Kww converted to Kdw. Assuming 16% solids, results in Kdw = 75366.8.
Kd = foc * Koc. If foc= 0.01 (assumes 1% organic carbon content) and Koc =1096478.2, then Kd = 10965.
BAF = Kww (L/Kg worm dw) / Kd (L/kg soil dw); thus, BAF = 12058.7/10965 = 1.1

(d) Due to the lack of uptake factors to worms, their concentrations were conservatively assumed to be equivalent to soil concentrations (USEPA, 2005).

(e) Total DDT is the sum of 4,4'-DDT, 4,4'-DDE, and 4,4'-DDD.

(f) HPAH - uptake factors based on benzo(a)pyrene.

(g) LPAH - uptake factors based on naphthalene.

Table H-3. Bioaccumulation Factors for COPECs Based on 95% UCL Soil Concentrations

COPEC	95% UCL Cs (mg/kg)	Soil to Plants (Cp)	Reference	Soil to Worms (Cw)	Reference	Soil to Small Mammals (Cm)	Reference
Antimony	0.264	0.011	EPA, 2005	0.26	EPA, 2005	0.001	EPA, 2005[a]
Cadmium	0.436	0.395	Bechtel-Jacobs, 1998	4.3	Sample et al., 1999	0.192	Sample et al., 1998b
Chromium	72.486	2.97	Bechtel-Jacobs, 1998	22.2	Sample et al., 1999	5.38	Sample et al., 1998b
Copper	25.878	7.03	Bechtel-Jacobs, 1998	13.3	Sample et al., 1999	12.3	Sample et al., 1998b
Lead	66.740	2.80	Bechtel-Jacobs, 1998	23.9	Sample et al., 1999	6.9	Sample et al., 1998b
Mercury	0.143	0.093	Bechtel-Jacobs, 1998	0.24	Sample et al., 1998a	0.008	Sample et al., 1998b
Selenium	0.443	0.207	Bechtel-Jacobs, 1998	0.51	Sample et al., 1999	0.486	Sample et al., 1998b
Silver	2.550	0.036	Bechtel-Jacobs, 1998	5.22	Sample et al., 1998a	0.010	Sample et al., 1998b
Thallium	0.121	0[b]	Efroymson et al., 1997	0.032	USACHPPM, 2004	0.012	Sample et al., 1998b
Zinc	73.803	52.4	Bechtel-Jacobs, 1998	350.7	Sample et al., 1999	106.4	Sample et al., 1998b
Total PCBs	0.070	0.00035	Travis and Arms, 1988	0.077	Jager, 1998[c]	0.245	Travis and Arms, 1988
Total DDT[e]	0.121	0.02	Bechtel-Jacobs, 1998	1.38	EPA, 2005	0.72	EPA, 2005[a]
2,6-DNT	0.185	0.44	Travis and Arms, 1988	0.19	Assumed[d]	0	ATSDR, 1998
HMX	0.690	4.67	CH2MHill, 2005	0.69	CH2MHill, 2005	0	Assumed negligible
HPAH[f]	0.093	0.013	EPA, 2005	0.124	Jager, 1998	0	EPA, 2005
LPAH[g]	0.021	0.256	EPA, 2005	0.092	Jager, 1998	0	EPA, 2005

DDT - dichlorodiphenyltrichloroethane
2,6-DNT – 2,6-dinitrotoluene
EXP – exponential
PCB – polychlorinated biphenyl
C_s – concentration in soil
C_p – concentration in plant
C_w – concentration in worm
C_m- concentration in mammal

(a) The regression equations cited in USEPA (2005) for uptake of antimony and Total DDT to small mammals is based on a diet comprised of 100% invertebrates (worms). To be consistent with wildlife at this site, small mammal concentrations were based on a herbivorous diet (i.e., 100% plants) as in the case of the vole.

(b) Assumed to be negligible.

(c) To determine earthworm uptake factors for PCBs: regression equations from Jager, 1998 were used as follows:
log Kww = 0.87*log Kow – 2
where Log Kow = 6.99 and Kww = 12058.7; Then Kww converted to Kdw. Assuming 16% solids, results in Kdw = 75366.8.
Kd = foc * Koc. If foc= 0.01 (assumes 1% organic carbon content) and Koc =1096478.2, then Kd = 10965.
BAF = Kww (L/Kg worm dw) / Kd (L/kg soil dw); thus, BAF = 12058.7/10965 = 1.1

(d) Due to the lack of uptake factors to worms, their concentrations were conservatively assumed to be equivalent to soil concentrations (USEPA, 2005).

(e) Total DDT is the sum of 4,4'-DDT, 4,4'-DDE, and 4,4'-DDD.

(f) HPAH - uptake factors based on benzo(a)pyrene.

(g) LPAH - uptake factors based on naphthalene.

Table H-4. Bioaccumulation Factors for COPECs Based on Background Soil Concentrations

COPEC	Background Cs (mg/kg)	Soil to Plants (Cp)	Reference	Soil to Worms (Cw)	Reference	Soil to Small Mammals (Cm)	Reference
Antimony	0.37	0.016	EPA, 2005	0.37	EPA, 2005	0.001	EPA, 2005 [(a)]
Cadmium	0.64	0.487	Bechtel-Jacobs, 1998	5.8	Sample et al., 1999	0.230	Sample et al., 1998b
Chromium	107	4.39	Bechtel-Jacobs, 1998	32.7	Sample et al., 1999	7.16	Sample et al., 1998b
Copper	48.8	9.02	Bechtel-Jacobs, 1998	25.1	Sample et al., 1999	13.5	Sample et al., 1998b
Lead	30.7	1.81	Bechtel-Jacobs, 1998	12.7	Sample et al., 1999	4.9	Sample et al., 1998b
Mercury	0.42	0.274	Bechtel-Jacobs, 1998	0.71	Sample et al., 1998a	0.023	Sample et al., 1998b
Selenium	0.24	0.105	Bechtel-Jacobs, 1998	0.33	Sample et al., 1999	0.386	Sample et al., 1998b
Silver	0.21	0.003	Bechtel-Jacobs, 1998	0.43	Sample et al., 1998a	0.001	Sample et al., 1998b
Thallium	1.5	0	Efroymson et al., 1997	0.395	USACHPPM, 2004	0.153	Sample et al., 1998b
Zinc	92	59.1	Bechtel-Jacobs, 1998	377.0	Sample et al., 1999	108.0	Sample et al., 1998b

C_s – concentration in soil
C_p – concentration in plant
C_w – concentration in worm
C_m- concentration in mammal
(a) Note that antimony is modeled using a diet of 100% plants to small mammals, to be consistent with the wildlife at this site (i.e., herbivorous diet).